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CONTENTS

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A COMPARISON OF LABOUR PRODUCTIVITY IN JAPANESE AND AMERICAN MANUFACTURING INDUSTRY[1]

By Kenzo YUKIZAWA*

I The Concept and the Significance of Productivity Comparison

The primary object of this paper lies in attempting to measure the physical productivity of labour in Japanese manufacturing industry in comparison with that of the U.S.A. The present survey was conducted, based on the respective *Census of Manufactures* in each country as its principal data, in regard to the two selected periods of 1958–59 and 1963. The comparative studies on British and American manufacturing industry conducted by L. Rostas and Professor Marvin Frankel are known as the most notable works in this field.[2] Similarly noteworthy are the achievements arrived at by Miss D. Paige and Professor Bombach[3] in attempting to make a comparison of individual net output per capita for the whole of British and American industry. However, it was decided that my present survey should be made along the lines of researches conducted by L. Rostas and Professor M. Frankel, in which out of all branches of manufacturing industry only such products whose physical output was measurable were taken up as inclusive objects of study.

Now, taking the physical output of product $i(i=1, 2, \ldots, n)$ to be represented by q^i, and its labour input l^i, the physical productivity per worker p^i can be measured in terms of q^i/l^i. Then, the following formula as an individual index of productivity p^i_{10} can be obtained to represent the level of productivity with respect to each product of country one on the basis of country zero:

$$p^i_{10} = \frac{q^i_1}{l^i_1} \bigg/ \frac{q^i_0}{l^i_0} = (p^i_1/p^i_0)$$

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* Professor, Institute of Economic Research, Kyoto University

1) I am indebted to Mr. Maxwell R. Conklin of the U.S. Bureau of the Census, Mr. Leon Greenberg of the U.S. Department of Labor and Mr. J. Lighthart of the Economic Commission for Europe for the necessary information.

2) L. Rostas, *Comparative Productivity in British and American Industry*, The National Institute of Economic and Social Research, Occasional Papers XIII, Cambridge University Press, 1948; M. Frankel, *British and American Manufacturing Productivity: A Comparison and Interpretation*, *University of Illinois Bulletin*, No. 81, University of Illinois, 1957.

3) D. Paige and G. Bombach, *A Comparison of National Output and Productivity of the United Kingdom and the United States*, OEEC, Paris, 1959.

What has been pursued in the present survey is, fundamentally speaking, none other than the quantitative approach toward this concept. The next step is, aggregating these individual indices in conformity with the formulae set forth later, to make an evaluation of the aggregate indices of labour productivity P_{10} by means of which we can conjecture the relative level of efficiency of material production and indirectly, the relative level of real income per capita in each country as a whole. The indices also show how overall productivity is a result of the industrial structure and of productivity in individual industries. Figure 1 shows some of the results of such an aggregation.

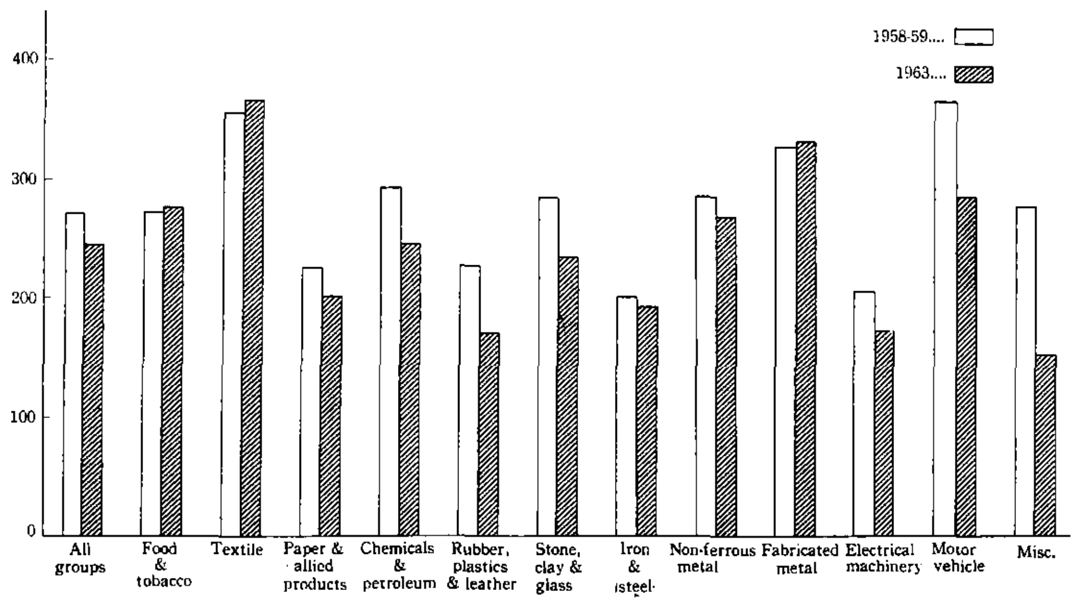

Fig. 1. Output per head comparisons in Japanese and American Manufacturing Industry, Averages by major industry groups: Japan = 100
Source: Indices (A) of Table 3.

Besides, there is a specific significance in making a comparison with the productivity of a specific nation, namely *that of the U.S.A.* In particular, we may safely assume that the attainable level of productive efficiency at the present time is found, in most cases,to have materialised in the actual level of productivity in American industry. It also necessarily implies the particular significance that any disparity in productivity disclosed by the comparison with America constitutes an assured possibility of increasing productivity. In other words, it is concerned with the part played by the pace-maker in a Marathon race, as it were, in the sense that it could be a target to catch up or surpass.

Furthermore, conducting this kind of international comparison with respect several points of time, will lead to the disclosure not merely of any disparity in the level of productivity at any given time, but also of the actual uneven rate of growth of productivity, thereby making it possible to throw light on the possible factors affecting the causes for this.

II Productivity Comparison

(1) Outline of the Method Adopted

As for the periods of comparison sampled, the years 1958 and 1963 were chosen for the U.S.A. because the two most recent census surveys in that country were carried out in these years and as for Japan the year 1959 was chosen for comparison with the year 1958 in the U.S.A. in view of the trends of labour productivity in Japan. Consequently the comparison has been made with regard to the two periods of 1958–59 and 1963 respectively. However, as to motor vehicles, for which measured values were obtained by a different method, the comparison has been made with respect to the years 1960 and 1965 for both countries, and as to iron and steel with respect to the years 1960 and 1964.

The following method of sampling particular industrial groups as objects to be compared has been used: first only particular products of such nature that would not lead to any serious errors in making comparisons of *physical* volume of output were picked out and then out of them only products of such nature that would be least affected by any possible error in assessing labour input were selected. The determination of the latter has something to do with the magnitude of values called the "specialization ratio" which will be explained later. At any rate, through this screening process, there finally remained sixty products of manufacturing industry, the list of which is shown in Appendix Table A2. The relative weight exercised in the whole manufacturing industry by the observed branches to which the said products belong, i.e. the coverage, can be shown in Table 1 as follows:

Table 1. Coverage by Selected Products

	Japan		U. S. A.	
	Number of Employees	Value Added (gross)	Number of Employees	Value Added (gross)
1958–59	27	39	23	26
1963	27	46*	21	27

* Net value added.

Finally, as to the labour input needed to produce these products, its measurement was taken in the following manner. First, the labour engaged in the manufacturing process of each industry defined by the Census of Manufactures, i.e. only so-called "present" labour was measured and accordingly, such labour as was needed for the production of raw materials and of the worn parts of fixed facilities, i.e. so-called "past" labour was not included in my calculation. This was chiefly because of the limited nature of the data.

Secondly, it is not necessary to say that it is preferable to measure both man-year and man-hour productivity, each of which has its own significance[4], but in my present study only the man-year comparison has been adopted because of the limited nature of data in Japan. Thirdly, it must be pointed out that the extent of labour input is interpreted only for production-workers in some cases, while in other cases it also includes indirect labourers. These two types of labour input having mutually supplementary meanings, both productivity per worker and per employee have been calculated in my present study. Then, since the recent progress in technology tends to increase the weight upon indirect labour more than upon direct labour in many cases, it has been decided for the purpose of obtaining an aggregate index to depend on the results of productivity per employee.

Fourthly, differences in sex, age and skill have not been taken into consideration in the present calculation of labour input, and international differences in these spheres have rather been left to be discussed afterwards as some of the causes for the disparity in the figures calculated.

(2) **Productivity Indices of Individual Products**

In Table 2 are shown the results of calculations to obtain the American labour productivity indices—$p_{10}^{t} = \frac{q_1^t}{l_1^t} \Big/ \frac{q_0^t}{l_0^t}$ taking Japan as the base country for each of the sixty products selected in the present survey. The products in Table 2 are arranged in order starting with the product of smallest magnitude of productivity indices *per employee* in 1963, in other words in such order that a product whose productivity in Japan is closer to that of the U.S.A. or surpasses it comes first. As to the year 1963 the measured values of indices *per production worker* are also indicated. It should be noted in this connection that the "Reference Number" quoted there means the ordinal number of the products shown in Appendix Table A2, put in order according to the Japanese census code numbers. According to Table 2 it is observed that the productivity of Japanese manufacturing industry is scattered over a range varying from the American level of productivity down to approximately one tenth of it.

When British and American productivity was compared, one point to be specially noted in this connection is that, in contrast to the fact that the productivity for each product in British manufacturing industry was found to be scattered within a range varying from the American level of productivity down to approximately one fifth of it both for the prewar and immediately post-war periods[5], the extent of scattering in the case of Japan is considerably greater than in the case of the United

4) L. Rostas, *op. cit.*, pp. 25.

5) L. Rostas, *op. cit.*, Table 5, p. 35 and M. Frankel, *op. cit.*, Table 1, p. 17.

Table 2. Indices of Physical Productivity of Labour between US and Japan, Individual Products

Ordinal Number According to Column (a)	Reference Number of Product**	Product Title	Productivity Indices(p^i), US versus Japan			
			1963		1958~59	
			(a) Per Employee	(b) Per Production Worker	(c) Per Employee	(d) Ordinal Number, by Column (c)
1	[54]	Radio and TV receiving type electron tube	○ 74	73	107	2
2	[59]	Pencil, nonmechanical	90	98	117	3
3	[33]	Leather gloves	102	99	153	8
4	[34]	Sheet glass, except tinted	○ 104	108	102	1
5	[35]	Cement, hydraulic	◎ 128	119	166	11
6	[1]	Canned seafood	○ 145	155	133	4
7	[16]	Paper	150	142	160	9
8	[57]	Watch	○ 150	157	259	25
9	[40]	Steel castings	156	154	137	6
10	[30]	Tire	158	160	189	13
11	[14]	Woven carpet and rug	159	167	282	33
12	[53]	Home-type television set	○ 159	139	136	5
13	[52]	Household refrigerator	○ 161	161	265	28
14	[60]	Match	168	177	307	37
15	[9]	Carded and combed cotton yarn	◎ 171	166	161	10
16	[58]	Piano	◎ 177	193	392	46
17	[38]	Steel rolling and finishing	◎ 178*	156*	190†	14
18	[23]	Acetate yarn	○ 179	168	148	7
19	[48]	Aluminum castings	179	172	227	21
20	[29]	Petroleum products	185	149	238	22
21	[32]	Footwear, except rubber	186	172	266	27
22	[17]	Paperboard	193	177	248	24
23	[26]	Printing ink	○ 194	169	277	31
24	[24]	Synthetic organic fibers except cellulosic	○ 202	258	261	26
25	[5]	Beer and ale	◎ 208	248	220	19
26	[50]	Bolt, nut and rivet	210	226	208	17
27	[21]	Plastic materials	211	232	289	34
28	[47]	Brass, bronze, copper castings	214	210	206	16
29	[22]	Rayon yarn	◎ 222	244	220	20
30	[18]	Fertilizer	231	208	204	15
31	[7]	Manufactured ice	◎ 238	259	273	29
32	[10]	Wool yarn, including carpet and rug yarn	○ 248	243	291	35

Ordinal Number According to Column (a)	Reference Number of Product**	Product Title	Productivity Indices (p^i), US versus Japan			
			1963		1958~59	
			(a) Per Employee	(b) Per Production Worker	(c) Per Employee	(d) Ordinal Number, by Column (c)
33	[39]	Iron and steel forgings	◎ 249	228	167	12
34	[2]	Wheat flour	255	258	302	36
35	[45]	Copper rolling and drawing	259	265	212	18
36	[42]	Malleable iron castings	273	275	316	40
37	[11]	Cotton broad woven fabrics	284	267	345	41
38	[56]	Motor vehicle and equipment	296††	278††	388†	44
39	[8]	Tobacco	302	238	287	32
40	[43]	Zinc slab, including remelt zinc	302	309	526	52
41	[46]	Aluminum rolling and drawing	308	315	322	40
42	[44]	Refined unalloyed aluminum	311	268	392	45
43	[41]	Gray iron castings	319	313	310	38
44	[31]	Reclaimed rubber	325	353	358	43
45	[51]	Steel spring	350	346	483	48
46	[3]	Refined cane sugar	360	390	242	23
47	[19]	Inorganic calour pigment	371	374	667	56
48	[49]	Metal can	376	351	345	42
49	[25]	Fatty acid	390	416	271	30
50	[36]	Brick	390	390	463	47
51	[55]	Storage battery	393	406	477	49
52	[37]	Lime	397	426	595	55
53	[6]	Starch	454	533	537	50
54	[13]	Wool fabrics	590	546	522	51
55	[27]	Industrial explosive	624	645	561	53
56	[15]	Wood pulp	698	482	772	57
57	[12]	Woven fabrics, man made fiber and silk	708	699	591	54
58	[28]	Glue and gelatin	907	924	1,063	58
59	[4]	Wine and brandy	1,126	1,294	1,091	59
60	[20]	Compressed and liquefied gas	1,129	1,222	1,054	60

† 1960, †† 1965, * 1964, ** See Appendix Table A2 below.

◎ Branches liberalized for foreign direct investment in mid-1967. One hundred per cent foreign holdings are free.

○ Branches where fifty per cent foreign holdings are made free since mid-1967.

Kingdom, which seems to provide grounds for inferring the hetergeneous structure of Japanese manufactruing industry in contrast to European or American industry.

The next point deserving notice is the fact that considerable fluctuations have been observed in the order of indices of productivity during the two periods, 1958–59 and 1963. In this connection it can be said that these fluctuations, if not ascribable to a serious error in measuring, should be regarded as indications of the very dynamic character of the two national economies, uneven developments among various industrial groups and their international disproportion, suggesting very acute changes in international competitiveness. Furthermore, it came to notice that Japanese labour productivity for some products in the year 1963 did in fact surpass that of the U.S.A. Although the measured differences are still too small to be outside the scope of measurement error, this phenomenon was not observed at all in the period 1958–59.

Some of these features seem to be fairly closely related to the scale of production, which we will discuss later.

(3) **Aggregate Indices of Productivity**

There are several formulae for calculating the level of productivity of an industrial group or of manufacturing industry as a whole, using aggregated productivity indices of individual products shwon above. In the present study only the number of employees has been adopted as weight in order to aggregate the individual indices, resulting in the following two kinds of aggregate indices: (A) aggregate indices weighted by the number of American employees l_1 and (B) aggregate indices weighted by the number of Japanese employees l_0: each of these having its own peculiar meaning.

Letting r represent unit labour requirement l/q, then r_1^i, for instance, can be regarded as figure representing the required quantity of labour to produce a unit of product i in America, i.e. a kind of measure of efficiency of American labour, and it can also be regarded as the labour value of the product in terms of American labour. There also exists such a relationship as $l=rq$. Then it follows

$$\text{Aggregate indices (A)} = \frac{\sum_i (p_1^i/p_0^i)\, l_1^i}{\sum_i l_1^i} = \frac{\sum_i (r_0^i/r_1^i)\, r_1^i q_1^i}{\sum_i r_1^i q_1^i} = \frac{\sum_i r_0^i q_1^i}{\sum_i r_1^i q_1^i} \cdots (1)$$

This numerator $\sum_i r_0^i q_1^i$ signifies the aggregate of the labour input that would be required if each item of product i were produced in Japan just as much as in the U.S.A. (q_1^i) at the rate of Japanese efficiency (r_0^i). And the denominator $\sum_i r_1^i q_1^i$ singifies the aggregate of the required labour input on the assumption that the same volume of each item is to be produced at the American rate of efficiency. In other words, this aggregate index (A) can be taken to be an indicator showing how many times more labour would be required in Japan relative to America, if both countries' physical composition and scale of production were the same as those actually realized in the U.S.A.. The results obtained by using this method have partly been shown in Figure 1, above.

The meaning of aggregate index (B) can also be clarified by developing the formula in a similar manner. That is,

$$\text{Aggregate index (B)} = \frac{\sum_i l_0^i}{\sum_i (p_0^i/p_1^i) l_0^i} = \frac{\sum_i r_0^i q_0^i}{\sum_i r_1^i q_0^i}$$

Therefore, in this case it indicates how many times more labour iput Japan requires, assuming that each country is to produce each item in just the same amounts as actual production in Japan[6)].

Table 3 shows the results of such aggregations with respect to all the products and each industrial group (two digit code) for both the years 1958–59 and 1963. It must be kept in mind throughout Table 3 that the calculated values listed there are concerned only with the products selected as objects of the present study, out of many other products belonging to the respective group of industry, and consequently whether or not the values can be regarded as reflecting the real situation of one whole industrial group depends upon how much the products selected represent the general circumstances in their own industries. The fact that there are differences between the measured values (A) and (B) is due to differences in the physical composition of production between the two countries, as already clarified. Therefore, another result obtained from the aggregate indices (C) which could in one sense be interpreted to indicate an average of (A) and (B) is added. The method of calculating it runs as follows:

$$\text{Aggregate index (C)} = \frac{\sum_i r_0^i (q_0^i + q_1^i)}{\sum_i r_1^i (q_0^i + q_1^i)}$$

therein signifing the ratio of the total labour input required, for the respective country assuming that, with respect to each product, both countries are to produce

6) The right side of the formula (1) can also be transformed in the following manner: if we make L represent the total labour input of each country, that is $\sum_i l^i$, then

$$\frac{\sum_i r_0^i q_1^i}{\sum_i r_1^i q_1^i} = \frac{\sum_i r_0^i q_1^i}{\sum_i r_0^i q_0^i} \Bigg/ \frac{\sum_i r_1^i q_1^i}{\sum_i r_0^i q_0^i} = \frac{\sum_i r_0^i q_1^i}{\sum_i r_0^i q_0^i} \Bigg/ \frac{\sum_i l_1^i}{\sum_i l_0^i} = \frac{\sum_i r_0^i q_1^i}{\sum_i r_0^i q_0^i} \Bigg/ \frac{L_1}{L_0}$$

That is to say, the numerator of the right side represents the index number of quantity of production weighted by the unit of labour value of the base country r_0^i, the denominator representing the index number of employment between the countries. In short, what is sought here are the cross-section indices of productivity as a result obtained by dividing the indices of production by the indices of employment. Needless to say, indices (B) can also be transfomed, in a similar manner, into:

$$\frac{\sum_i r_1^i q_1^i}{\sum_i r_1^i q_0^i} \Bigg/ \frac{L_1}{L_0}.$$

Table 3. Summary Table, Aggregated Indices of Labour Productivity between US and Japan

Industrial groups and US Census Code		Reference number of product	Aggregated indices of labour productivity						Indices of productivity growth	
			1963			1958~59				
			Indices (A)	Indices (B)	Indices (C)	Indices (A)	Indices (B)	Indices (C)	Japan 1963/1959	US 1963/1958
All groups	(20~39)	[1]~[60]	**247**	**219**	**244**	**276**	**243**	**271**	**142**	**125**
Food and tobacco	(20, 21)	[1]~[8]	276	256	272	274	245	268	121	122
Textile mill products	(22)	[9]~[14]	368	276	345	357	296	339	127	124
Paper and allied products	(26)	[15]~[17]	203	215	204	228	237	229	152	124
Chemicals and petroleum products	(28, 29)	[18]~[29]	247	224	243	295	254	289	173	140
Rubber, plastics and leather products	(30, 31)	[30]~[33]	172	163	171	229	202	227	140	108
Stone, clay and glass products	(32)	[34]~[37]	236	157	217	286	209	271	159	121
Iron and steel	(331, 332)	[38]~[42]	195	194	195	202	202	202	133	128
Nonferrous metal	(333, 335, 336)	[43]~[48]	271	254	269	287	258	284	144	136
Fabricated metal products	(34)	[49]~[51]	333	257	317	327	260	315	115	107
Electrical machinery	(36)	[52]~[55]	172	146	162	207	154	195	173	138
Motor vehicles and equipment	(371)	[56]	296	296	296	388	388	388	156	119
Miscellaneous	(38, 39)	[57]~[60]	155	151	153	279	252	271	163	96

Index (A) $= \dfrac{\sum (p_1/p_0) l_1}{\sum l_1}$, Index (B) $= \dfrac{\sum l_0}{\sum (p_0/p_1) l_0}$, Index (C) $= \dfrac{\sum r_0 (q_0+q_1)}{\sum r_1 (q_0+q_1)}$

Index of productivity growth $= \dfrac{\sum (p^{63}/p^{58}) l^{63}}{\sum l^{63}}$ or $\dfrac{\sum (p^{63}/p^{59}) l^{63}}{\sum l^{63}}$

p: output per head of individual product, (q/l)

Suffix 0 denetes Japan, and 1 the United States.

by an amount which is equal to the sum of the volume actually produced by the two countries.

Judging from the indices calculated according to the respective methods described above, it has been disclosed, as far as all the products selected as objects of the present study are concerned, that labour productivity in American manufacturing industry was 2.4–2.7 times greater than that in Japan in the period 1958–59, and 2.2–2.5 times greater in the year 1963.

Secondly, we have found that the disparity in productivity between the two countries decreased by approximately 10% during the period between 1958–59 and 1963, and that this came from the disproportionate rate of growth of productivity in the two countries. The time series indices of productivity for each country were measured and shown in the far righthand column of Table 3 in order to clarify the state of things during the said period. Letting primed notations represent the figures for 1963, the formula of the calculation runs as follows:

$$\frac{\sum_i (p'^i/p^i)l'^i}{\sum_i l'^i} = \frac{\sum (r/r')r'q'}{\sum r'q'} = \frac{\sum rq'}{\sum r'q'}$$

The markings of product i are omitted with the exception of the left side of the above formula. The resulting figures of this formula after all would signify how many times the labour input might be required at the rate of efficiency in the year 1958 or 1959 in comparison with the rate of efficiency in the year 1963, assuming that the volume to be produced for both years with respect to each item of the products is to be just as much as that actually produced in the year 1963, thus to be equal to q'^i $(i=1, 2, \ldots, n)$.

When the results thus obtained are examined, it is disclosed that labour productivity in the U.S.A. did in fact increase by 25% in the five years covering the period from 1958 to 1963: roughly speaking, a fairly rapid growth rate of productivity, i.e. 5% annually, was achieved. It was observed that a very rapid growth rate was achieved especially in such industries as chemicals, petroleum, metals, electric machines.

However, as a matter of fact a far greater rate of growth of productivity than that in the U.S.A. took place in Japan. The actual state of such growth is a little more conspicuous than what the mere numerical values of Table 3 suggest. In short, the reason is that the numerical values for Japan are limited to only a four year period from 1959 to 1963. Speaking as a whole, Japan achieved a 42% growth during these four years, i.e. roughly speaking an annual growth rate of 10%, which was about twice as rapid as that in the U.S.A. The particular groups of industries achieved such a conspicuously rapid growth are likewise found to be industries such as petroleum, cheimcals, electrical machines and automobiles, which corresponds to the situation in the U.S.A. Anyhow, no one can help mentioning that it was in fact a noteworthy rate of growth as a whole.

Of course the aforementioned results cannot be entirely free from some overevaluation, to some extent on account of the limited nature of the necessary data. This particular circumstance should rather have been explained in II (1), but the scope of coverage of the census survey with respect to scale of establishment in Japan is in some measure narrower than that in the U.S.A., and moreover it was more conspicuously so in 1963 than in 1959. In other words, only establishments without any employee are excluded from the American census, and the value of shipment of the enterprise excluded in such a manner accounts for only 0.25% of all manufacturing industry in 1958, which can almost be disregarded.

In contrast with this, in the case of Japan all workshops with three employees or less are excluded and the respective weights of those parts account for 2% in the value of shipments and miscellaneous receipts, 5.8% in the number of employees, and 52.2% in the number of establishments. Moreover, since the Japanese Census of Manufactures for 1963 does not show any detailed data with respect to workshops with nine workers or less these portions have had to be excluded from the present study. Their respective weight stands at 6% in the value of shipments, 17% in the number of employees and 74% in the number of establishments, which are no small percentages.

It can clearly be seen from the difference in weight between the value of shipments and the number of employees that such parts which are excluded in that manner are composed of small enterprises of very low productivity. Accordingly the numerical values listed in Table 2 and 3 to some extent show the overvalued Japanese productivity and this tendency is more conspicuous in 1963. Because the weight of workshops taken up in the present study covers 94% in value of shimpments and 83% in the numberiof employees, it must have given rise to an error of approximately 10% in 1963. Concurrently this fact has to be taken into consideration in making estimate of the growth rate of Japanese producivity because of possible errors of the same nature.

On the other hand, the aforementioned statement is not applicable to such industries as iron and steel, motor vehicles, cotton yarn, woolen yarn, tobacco and wood pulp which have been measured by means of different data and, sometimes, in a different way. To these cases we shall refer later.

Then, let us see the relative position of the level of labour productivity in Japanese manufacturing industry in comparison with that of European countries. Because my comparative study between Britain and Japan has not yet been completed, a very rough estimate may be given here. According to the aforementioned study of Proferssor M. Frankel in regard to thirty-four industrial groups, American labour productivity was found to be approximately 2.7 times greater than that of Britain in 1947–48. The growth rate of productivity thereafter was found to be faster in America than in Britain. For instance, according to the study of Professor E.D. Domar and others the annual rate of growth of labour productivity in American manufacturing industry was found to be 3.4% in the period covering 1948–60 and 2.0% for Britain in the period covering 1950–59[7]. If these findings are to be accepted as they are, the level of productivity in American manufacturing industry in 1958–59 should be approximately three times as high as that of Britain.

Since the level of American labour productivity in the corresponding period, according to my study, is approximately 2.7 times as high as that of Japan, it is justifiable in my opinion to draw the conclusion, after taking such factors as longer working hours during the year and errors in measurement into consideration, that the level of labour productivity in Japanese manufacturing industry must have practically reached that of European countries. In the meanwhile, according to another data, the level of Soviet labour productivity in 1958 is estimated to be 45% of that in America[8].

III A Few Comments on the Results

(1) Market Size and Productivity

As already pointed out, the individual productivity indices for both countries vary over a wide range from product to product, suggesting that Japanese industry had to develop under qualitatively different circumstances from those in Europe or America. Now, in order to do research on those factors that may cause such variations in labour productivity it is necessary, as pointed out by L. Rostas, to make a detailed suvey with respect not merely to common factors, such as the size of market and factory and standardization on the one hand, but also specific factors arising from individual industries on the other.

However, it must be also noted that, because even the 'common' factors are after all subject to different technical conditions as required by the different industrial groups, it becomes more or less necessary to study the bais of each product by all methods. Although this has not yet been worked out in my present survey, it can be pointed out that, as far as the two extremities of the variation in individual productivity indices shown in Table 2 are concerned, the scale of production and consequently the size of market can be taken as fairly justifiable factors to account for the difference in labour productivity.

Now, let us see this in the light of Table 4. Five products are picked out from products shown in Table 2 in the order of the highest and lowest productivity per employee respectively, and their productivity indices and relative size of market are contrasted in that table. It shows that the Japanese labour productivity of the first five products in the list appear to have been on approximately the same level as

7) E.D. Domar, and others, "Economic Growth and Productivity in the United States, Canada, United Kingdom, Germany and Japan in the Post-War Period", *Reveiw of Economics and Statistics*, Vol. 46, 1964, p. 36.

8) D.N. Karpuknin, "Labour Productivity in the USSR and the USA", *Problems of Economics*, New York, International Arts and Science Press, Vol. 5, No. 5.

Table 4. Size of Market at the Extremes of Relative Productivity, 1963

Rank According to Relative Productivity	Product	Productivity Index per Employee, 1963 (U.S.A./Japan; Japan=100)	Relative Size of Market, 1963 (U.S.A./Japan: Japan=1)
1	Electron Tube	74%	1.6 times
2	Pencil	90	0.8
3	Leather gloves	102	2.8
4	Sheet glass	104	1.5
5	Cement	128	2.1
56	Wood pulp	698	4.4
57	Woven fabrics, man made fiber and silk	708	13.0
58	Glue and gelatin	907	13.4
59	Wine and brandy	1,126	110.9
60	Compressed or liquefied gas	1,129	17.3

American labour productivity, and that the disparity in the market size is comparatively speaking not so great, distributed from 0.8 times to 2.8 times.

On the other hand as contrasted with these findings, with respect to the Japanese labour productivity of the five products in the list having the lowest comparative productivity, the American productivity of respective product is found to be 7 to 11 times as high, and with respect to the market size 4 products are found to be more than 10 times as large, putting aside the wood pulp industry which is 4 times as large. Incidentally the relative market size of all the products selected for the present study is, with the exception of 110 times for wine, and 46 times for ordinary bricks, distributed between 17 times for compressed and liquefied gas and 0.7 times for watches, and their median value is approximately 5.

Generally speaking, it is not always justifiable to link the size of market (as measured by the volume of output) directly with the level of productivity[9]. But, as far as the results of this paper are concerned, the coefficient of correlation between relative productivity and relative size of production in 1963 concerning all the sixty products examined is equal to 0.54, significant even within a 0.01 level of confidence.

When the coefficient of correlation of productivity and market size is examined with respect to the respective growth rate in each country during the period covering from 1958–59 to 1963, the higher coefficient of correlation is found, i.e. 0.67 for Japan and 0.69 for the U.S.A. It can easily be deduced that the adoption of new techniques

9) L. Rostas, *op. cit.* pp. 58 and M. Frankel, *op. cit.*, pp. 64.

will be put into practice much easier by such industrial groups as are making rapid growth in their output through ever-increasing investment for industrial facilities and equipment and that a very high coefficient of correlation of this kind will be found in a dynamic economy.

(2) **Level of Productivity and Liberalization of Direct Investment**

Next, in connection with the individual productivity indices, the relationship with somewhat current topics will be taken up. It was in June 1967 that the policy of liberalization of direct foreign investment for selected branches of Japanese industry was made public and among products of industrial groups for which either 100% or 50% foreign holdings became free such selected products that are examined for this study are marked respectively with ◎ or ○ in Table 2. It can easily be understood that these products are concentrated higher in the ranking order and, accodingly, belong to those branches of Japanese industry whose productivity level is relatively nearer to that of the U.S.A. This fact suggests that the capital equipment for these products in Japan is relatively similar to that in the U.S.A. and that it can much more easily stand against foreign capital. Hence, it is not hard to believe that these corresponding relationships can be regarded as theoretically supported, and contrariwisely the trustworthiness of the present comparative survey is backed up to a considerable extent.

(3) **Relative Productivity and Relative Wage Level**

Next consideration will be given here to the relative levels of productivity in the two countries shown on the aggregate productivity indices (Table 3) in the light of the relative levels of nominal wages in the two countries. In contrast to the fact that the disparity in labour productivity of America against that of Japan in the period 1958–59 is approximately 2.7 times, the disparity in nominal wage per head in the manufacturing industry is as wide as approximately 6 times, when converted at the official exchange rate. Similarly in the year 1963 the disparity in productivity is about 2.4 times, while that in the nominal wage is as wide as approximately 5 times. Since the measurement of the level of productivity was conducted only for manufacturing industry, the disparity in the level of productivity between America and Japan should be a little wider apart when considering agriculture. Yet the disparity in the nominal wage is disproportionately wider in comparison with the disparity in the level of productivity, and for that reason it would be safe to conclude from the viewpoint of wage costs that Japan is in a fairly favourable situation.

The writer is of the opinion that one of the most important factors stilmulating the high growth rate of the Japanese economy can be sought in these relationships. In other words, as being hinted at by the disparity in productivity as wide as 2.2–2.5 times, a suitable technique corresponding to gradually higher levels of wages is ready for Japan to introduce, without her efforts for developing it herself, and the cost of labour power which can possibly be tied up with the available technique is still relatively inexpensive. These circumstances are partly helpful in providing Japan with a firm basis for price-competitiveness and partly advantageous for makeing a favourable stepping-stone for a high rate of profit and accumulation. At the same time when this situation is viewed from the aspect of foreign capital, it means that Japan constitutes a very promising market for the export of capital.

It was already pointed out that the level of productivity of Japanese manufacturing industry is just about the same as that of European countries, and one can speculate that the particular conditions for the growth peculiar to the Japanese economy will cease to exist as the level of Japanese nominal wages draws closer and closer to that of western Europe. Such prevailing conditions for the economic growth of Japan seem to have some relationship with the fact already pointed out to the effect that the Japanese individual production indices versus the U.S.A. vary to a greater extent than the British.

Appendix I Details of Measurement

AI–1 Volume of Product and Labour Input, General Method

The Japanese *Census of Manufactures* tells us the volume of shipments and that of stock. We have got the volume of production of each *product* from it. The *US Census* tells us either the volume of production, directly, or the volume of shipments. In the latter case, we can assess the volume of production indirectly, through formula (1).

$$(1) \quad \text{volume of production} = \text{volume of shipments} \times \frac{\text{value of production}}{\text{value of shimpents}}$$

where, value of production=value of shimpents+net increase in value of stock.

On the other hand, we can get the number of employees and workers of the industry *primarily* producing the corresponding product.

At this point, we should reflect on the way of industrial classification of the census survey. Usually, a reporting *establishment* produces not only a product belonging to Industry A but also other products belonging to Industries B,C etc. If the value of production of product A by *this establishment* exceeds that of B, C etc., then the figures of shimpment value and of labour reported by this establishment including the part which is related with product B, C etc., are added up as the figures of industry A. In this way, the figures of the volume of output *of a product* and those of labour input *of the industry primarily producing this product* which we get from the Census do not reflect exactly the same activity of production.

Appendix Table AI tells us the situation in a much simplified way. The Census statistics consist of value statistics V, quantity statistics Q and labour statistics L. *Industry* statistics tells us that Industry A produced both Product A and B and employed the number of labourers L_{41} for the production of both. *Product* statistics tells us that the quantity of production Q_{14} is produced by both industries A and B.

Appendix Table A1. Simplified Illustration of Industry and Product

(a) Illustration with Notations

	(1) Industry A	(2) Industry B	(3) Value of shipments [(1)+(2)]	(4) Quantity produced
(1) Product A	V_{11} (Q_{11}, L_{11})	V_{12} (Q_{12}, L_{12})	V_{13}	Q_{14} (L_{14})
(2) Product B	V_{21} (Q_{21}, L_{21})	V_{22} (Q_{22}, L_{22})	V_{23}	Q_{24} (L_{24})
(3) Value of shipments of industry [(1)+(2)]	V_{31}	V_{32}		
(4) Number of employees	L_{41}	L_{42}		

Statistics in the parentheses are not given.
V: value statistics (value of shipments)
Q: quantity statistics
L: labour statistics

(b) Example with assumed figures

	(1) Industry A	(2) Industry B	(3) Shipments	(4) Production
(1) Product A	1,000 $	100 $	1,100 $	150 ton
(2) Product B	300 $	900 $	1,200 $	250 ton
(3) Shipments	1,300 $	1,000 $		
(4) Number of employees	100	80		

Thus the exact correspondence between labour statistics and volume statistics concerning product A, for instance, can not be found.

In order to obtain the figures of output per head, we should connect either Q_{11} to L_{11} or Q_{14} to L_{14}. But in the former case, we can not find the statistics of Q_{11} and L_{11}, and can only find those of V_{11}. In the latter case, we can find the statistics of Q_{14}, but not those of L_{14}.

In our research work, we have chosen the former way, and thus, having already obtained Q_{14} and L_{41}, we have to assess Q_{11} and L_{11} using the following formulae:

(2) $Q_{11} = Q_{14} \times \frac{V_{11}}{V_{13}}$, by our example $Q_{11} = 150\,\mathrm{t} \times \frac{\$1{,}000}{\$1{,}100}$

(3) $L_{11} = L_{41} \times \frac{V_{11}}{V_{31}}$, by our example $L_{11} = 100 \text{ persons} \times \frac{\$1{,}000}{\$1{,}300}$

Then we can obtain output per head $P=Q_{11}/L_{11}$, which is expressed above by the notation $p^i=q^i/l^i$ for the product i. The ratio V_{11}/V_{13} of the formula (2) corresponds with what the *US Census* calls *coverage ratio* and V_{11}/V_{31} of the formula (3) *spacialization ratio*, and we use the same names in this paper.

By the above assessments, we are assuming, firstly, that the distribution of the volume of production of a product among industries of origin is proportinate to that of shipment value and, secondly, that the distribution of labour input among several products in the same establishment is proportionate to that of shipment value. Possible errors may mainly arise from these double assumptions, the second of which may be more serious, because, though the unit value of the same product may not differ greatly according to the difference of the industries of origin, the labour input per unit value of production may differ from product to product even among products of the same establishment.

The error from the second assumption would be smaller the larger the specialization ratio (V_{11}/V_{13}) is. We therefore, excluded the product whose specialization ratio is very small from our objects of measurement. This ratio for each product is shwon in Appendix Table A2. There is a slight difference between the specialization ratio in the *US Census* and that in this paper. In the former case the value of shipments of primary products is divided by that of primary and secondary products of each industry, whereas, in the latter case, the denominator becomes a little larger, adding further miscellaneous receipts of the industry.

There are some products whose productive consumption in the same establishment is considerable. For these products, the above way of deriving L_{11} [formula (3)] leads to major errors. In these cases, the adjustment for the specialization ratio (V_{11}/V_{31}) is required. Let us call the value of self-consumption in the same establishment S, and then the adjusted specialization ratio is obtained by adding S to both numerator and denominator. Thus, the adjusted specialization ratio is $(V_{11}+S)/(V_{31}+S)$, instead of V_{11}/V_{31}.

AI–2 Computations Depending on Conversion Ratio among Product Items Composing the Same Product Category

(a) Motor vehicles

The productivity index for the motor vehicle industry depends on a series of Professor A. Silberston's works. The main characteristics of his work, according to his former paper[10], are found in the folowing points:— Firstly, that he included as labour input not only the labourers employed in vehicle manufacturing firms them-

10) A. Silberston, Problems Involved in International Comparisons of Labor Productivity in the Automobile Industry; J.T. Dunlop and V.P. Diatchenko (ed.), *Labor Productivity*, London, McGraw-Hill, 1964.

selves but also those in all firms making parts and accessories for them. In this way, he has attempted to minimize the possible errors which may arise from the difference of degrees of integration between countries. Secondly, the volume of output in terms of the number of vehicles produced is adjusted by putting weight according to the kind of vehicles requiring diffferent volumes of labour input.

On the same lines, he has recently published, jointly with Mr. Cliff Pratten, a new paper[11] in which the calculations are extended to more recent years and some of the earlier figures have been revised. The productivity comparisons in their paper relate to 1950, 1955, 1960 and 1965. It is on their results for 1960 and 1965 that the productivity index of automobile industry in my paper depends. As a matter of fact, my paper has borrowed their figures about output per employee for the United States, but has made a little alterations about the corresponding figures for Japan. On the one hand, I have made another estimation of the number of employees of Japanese automobile industry excluding, in a different way, those engaged in making motor cycles from the official employment figures of Japanese motor industry. On the other hand, a more detailed statistics of the output of Japanese motor industry has made me possible to compute the output of Japan using the similar weights[12] as they used for the United States and European countries, whereas their work gave Japanese cars and commercial vehicles a uniform weight of 90 with the exception of buses[13].

The following table compares the various results about man-year productivity of the two countries' automobile industry.

Number of Vehicles Produced per Employee

Source	Country	1950	1955	1959	1960	1965
Prof. Silberston's former paper	USA*	10.7	11.5	11.0		
	Japan	1.6	1.9	2.5		
His new joint paper	USA*		11.8		12.4	14.8
	Japan		1.2		2.7	4.4
My revised figures	Japan				3.2	5.0

* Dividing by employees excluding those producing electrical equipment. Japanese figures do not include them either.

11) C. Pratten and A. Silberston, "International Comparisons of Labour Productivity in the Automobile Industry, 1950–1965", *Bulletin of the Oxford Institute of Statistics*, Vol. 29 No. 4, 1967.

12) *Ibid.*, p. 377.

13) Concerning the details of these alterations, I am going to write a note in the form of the mimeographed discussion paper, which will be sent free on request at Kyoto Institute of Economic Research, Kyoto University, Kyoto, Japan.

(b) Iron and steel

As regards international productivity comparison of iron and steel, the group of experts commissioned by the Steel Committee of the Economic Commission for Europe has developed a method of comparison[14] with elaborate conversion ratios based on the labour requirements per ton of output for each product group of this industry.

This work has published comparative productivity ratios of iron and steel for seventeen European countries, with the United States as the base country, for the years between 1960 and 1964.

In order to obtain Japanese ratios by the same method, I have asked the favour of computing them, sending the necessary data for Japan to the Statistical Office of the ECE, and have obtained the ratios of Japan versus the United States for 1960 and 1964[15].

Appendix II Selection of Products to be Compared

In order to obtain quantity statistics of production in *the Census of Manufactures*, we have to descend, so to speak, till we reach a very detailed Industrial Classification: that is, for the United States till a five to seven digit code of SIC and for Japan a six digit code. The industrial classifications of both countries differ considerably around such a detailed level of classifcation. The identification, therefore, of the classification of both countries has been the first task in the problem of selecting the products to be compared.[16]

Some products are omitted from our comparison because of the difference in units of measure for volume of production. More products are excluded because of the lower *specialization ratio*, which, as explained above, may lead to major errors in assessing labour input.

Finally sixty products were selected for comparison concerning their productivity. Appendix Table A2 shows a list of them arranged according to the code number of Japanese Industrial Classification. The far right hand columns show specialization ratio of each for both countries for both years.

14) ECE, *International Comparisons of Lobour Productivity in the Iron and Steel Industry*, U.N., New York, 1967.

15) The details are found in my paper 'ECE's approach to International Comparisons of Labour Productivity in the Iron and Steel Industry' (in Japanese) Hitotsubashi Institute of Economic Research, *Keizai Kenkyu* (*The Economic Review*), Vol. 18 No. 4, Tokyo, Oct. 1967.

16) The list of identification of both countries' industrial classifications has been mimeographed for both four digit code level and six-to-seven digit code level in the form of Discussion Papers (6601 and 6711) of Kyoto Institute of Economic Research, Kyoto.

Appendix Table A2. List of Products Compared in This Paper

Reference Number of Product	Product Title	Product Code of the Census of Manufactures[a)]		Specialization Ratio of the Industry			
				1963		1958～59	
		Japan	US	Japan	US	Japan	US
[1]	Canned seafood (except soups, stews and chamders)	1821	2031 (⓪00, 11, 31)	67	70	70	75
[2]	Whaet flour (except blended or prepared)	1852 ⑪	2041 ①	75	66	80	61
[3]	Refined cane sugar	1861 ⑫	2062 (−⓪75)	95	98	98	99
[4]	Wine and Brandy	1882 ⑪	2084 (⓪11～31)	92	69	86	74
[5]	Beer and ale	1883 ⑪	2082 (−⓪7, 8, 9)	96	97	95	98
[6]	Starch	1894 ⑪	2046 (⓪31,33,41,43)	91	28	90	35
[7]	Manufactured ice	1896 ⑪	2097 (⓪11)	69	44	81	47
[8]	Tobacco	b)	2111	98	97	97	99
[9]	Carded and combed cotton yarn	2021 ⑪	2281 (①10, ②10)	58	77	64	82
[10]	Wool yarn, including carpet and rug yarn	2023	2283 (①20)	60	77	66	67
[11]	Cotton broad woven fabrics	2031⑪～㉔	2211 (①～⑥)	33	67	45	46
[12]	Woven fabrics, man made fiber and silk	2032	2221 (①～⑦)	27	69	42	53
[13]	Wool fabrics	2033	2231 ②	90	38	93	43
[14]	Woven carpet and rug	2096⑪～⑫	2271	65	74	80	86
[15]	Wood pulp	2412⑪～⑯	2611	80	88	85	89
[16]	Paper (except building paper)	2421	2621	84	89	86	89
[17]	Paperboard	2423	2631	88	86	84	90
[18]	Fertilizer	2613	2871, 2872	60	85	71	90
[19]	Inorganic calour pigment	2623	2816, 2895	56	80	62	81
[20]	Compressed and liquefied gas	2624⑪⑫⑲	2813 ④	39	54	53	35
[21]	Plastic materials (synthetic resins, and nonvulcanizable elastomers)	2635	2821 (②～⑨)	37	57	64	75
[22]	Rayon yarn	2641	2823 ②	78	55	88	52
[23]	Acetate yarn (yarn, staple, and tow)	2642	2823 ①	97	34	86	29
[24]	Synthetic organic fiber except cellulosic	2643	2824	87	95	86	100
[25]	Fatty acid	2661⑪～⑭	2899 ②	25	58	51	62
[26]	Printed ink	2665⑪～⑬	2893	91	75	87	88
[27]	Industrial explosive	2691⑪～⑰	2892 ① (13～33)	55	38	64	49
[28]	Glue and gelatin	2696	2891	93	48	96	76
[29]	Petroleum products	2711⑪～㉘	2911	93	83	93	82
[30]	Tire	2811⑪～⑱	3011 ①②③	80	70	80	72
[31]	Reclaimed rubber	2831	3031	86	87	81	87
[32]	Footwear, except rubber	2941 ⑪	3141 ①②③	51	35	50	34
[33]	Leather gloves	2951	3151	79	69	77	79

Reference Number of Product	Product Title	Product Code of the Census of Manufactures[a)]		Specialization Ratio of the Industry			
				1963		1958~59	
		Japan	US	Japan	US	Japan	US
[34]	Sheet (window) glass (not rolled), except tinted	3011 ⑪	3211 ①	60	26	57	24
[35]	Cement, hydraulic	3021	3241	94	93	90	96
[36]	Brick	3032	3251 ①	92	79	90	73
[37]	Lime	3083	3274	91	76	93	73
[38]	Steel rolling and finishing	311~315	331	—	—	—	—
[39]	Iron and steel forgings	3161	3391	44	82	45	79
[40]	Steel castings	3163	3323	77	82	72	83
[41]	Gray iron castings	3171, 3172	3321	91	88	88	89
[42]	Malleable iron castings	3173	3322	64	86	79	85
[43]	Zinc slab, including remelt zinc	3213	3333 (④ 13)	46	61	49	58
[44]	Refined unalloyed aluminum	3214 ⑫	3334 ⑦	66	87	61	67
[45]	Copper rolling and drawing	3231	3351	64	85	57	81
[46]	Aluminum rolling and drawing	3233	3352	59	69	70	85
[47]	Brass, bronze, copper castings (excluding die)	3241⑪⑫	3362	46	62	53	63
[48]	Aluminum castings (excluding die)	3241⑬⑭	3361	32	35	37	36
[49]	Metal can	3311⑪⑫	3411 (⓪ 01)	65	91	67	96
[50]	Bolt, nut and rivet (except 7/16″ and under)	3371⑪⑫	3452 ①	60	31	62	25
[51]	Steel spring	3392⑪⑫	3493	38	73	47	58
[52]	Household refrigerator	3521 ⑯	3632 ①	32	53	22	55
[53]	Home-type television set	3543 ⑪	3651 (②01, 03, 05)	57	36	63	42
[54]	Radio and TV receiving type electron tube	3551 ⑪	3671	32	82	36	86
[55]	Storage battery (SLI type)	3591 ⑪	3691 ①	87	69	81	96
[56]	Motor vehicle and equipment	361	3713, 3715, 3717	85	—	77	—
[57]	Watch	3771 ⑪	3871 ④⑤	56	31	53	49
[58]	Piano	3921 ⑪	3931 ①	64	28	67	25
[59]	Pencil, nonmechanical	3942⑪⑫	3952 (①11~15)	81	30	92	37
[60]	Match	3986 ⑪	3983	88	92	89	100

a) Based on the 1963 Industrial Classification of both countries' Censuses. There have been some changes in the classification between 1958 and 1963. The Japanese product code is shown with a six digit code, the fifth and sixth digit in the round bracket. For instance 3771111 is designated as 3711⑪. The American product code with a seven digit code, the fifth digit in the round bracket. For instance 3952111 as 3952 ① 11.

b) Government Monopoly Statistics.